

WE CLAIM:

1. A human motion classification and measurement system, comprising:
 - sensors for sensing a human;
 - a motion classification unit connected to receive data from said sensors;
 - 5 an energy estimator unit connected to receive data from at least one of said motion classification unit and said sensors; and
 - a Kalman filter connected to receive data from said motion classification unit and from said sensors, said Kalman filter having an output connected to said motion classification unit and said energy estimator unit so that said energy estimator unit is operable to identify an
10 energy expenditure by the human.
2. A human motion classification and measurement system, comprising:
 - sensors for sensing a human;
 - an energy estimator unit and a health monitor unit connected to receive data from said sensors;
 - 15 and
 - a Kalman filter connected to receive data from said sensors and having an output connected to said energy estimator unit and said health monitor unit so that said energy estimator outputs an estimate of energy expended by the human and so that said health monitor outputs an indication of health of the human.
- 20 3. A human motion classification and measurement system as claimed in claim 2, further comprising:

an alarm connected to an output of said health monitor unit to indicate traversal of a threshold.

4. A human motion classification and measurement system, comprising:

a personal status sensor for mounting on a human;

motion sensors for mounting on a human;

- 5 a motion classification unit connected to receive data from said motion sensors and generate therefrom a motion type indicator signal; and
an output unit connected to said personal status sensors and to receive said motion type indicator signal, said output unit providing an output indicating a status of human activity of the human.

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5. A human motion classification and measurement system as claimed in claim 4, wherein said output unit includes an energy estimator unit operable to provide an estimate of energy expended by the human and a health monitor unit operable to activate an alarm upon traversal of a health threshold.

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6. A human motion classification and measurement system as claimed in claim 4, wherein said personal status sensor includes at least one of a heart rate sensor and a respiration sensor and a hydration sensor.

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7. A human motion classification and measurement system as claimed in claim 4, wherein said motion sensors are inertial sensors including gyroscopic sensors and accelerometers.

8. A human motion classification and measurement system as claimed in claim 4, further comprising:
 - an altimeter for mounting on the human and having an output connected to said motion classification unit; and
- 5 a magnetic sensor for mounting on the human and having an output connected to said motion classification unit.

9. A human motion classification and measurement system as claimed in claim 4, further comprising:
 - 10 a filter connected to receive data from said motion classification unit, said filter having an output connected to said motion classification unit and to said output unit.

10. A human motion classification and measurement system, comprising:
 - personal status sensors for mounting to a human;
 - 15 inertial sensors for mounting to the human;
 - an altimeter for mounting to the human;
 - a magnetic sensor for mounting to the human;
 - a global positioning satellite sensor for mounting to a human;
 - a motion classification unit having inputs connected to said inertial sensors and said altimeter
 - 20 and said magnetic sensors, said motion classification unit having outputs for data identifying motion type of the human and distance traveled by the human;
 - an energy estimator and health monitor unit having inputs connected to said personal status

sensors and said output of said motion classification unit for motion type data to output energy expenditure information on the human motion and to trigger an alarm upon traversal of a health threshold;

an inertial navigation unit connected to receive data from said inertial sensors and having a

5 navigation state output;

an input preprocessing unit having inputs connected to said global positioning satellite sensor and said magnetic sensor and said altimeter and said motion classification unit and having an output; and

a filter connected to receive data from said output of said input preprocessing unit, said filter

10 having an output connected to said motion classification unit and said energy estimator and health monitor units and said inertial navigation unit.

11. A human motion classification and measurement system as claimed in claim 10, further comprising:

15 a measurement prefilter connected between said input preprocessing unit and said filter; and
a human model provided as input to said measurement prefilter.

12. A human motion classification and measurement system as claimed in claim 10, further comprising:

20 an initial input to said input processing unit.

13. A human motion classification and measurement system as claimed in claim 10,
further comprising:
a human input to said input preprocessing unit.

- 5 14. A human motion classification and measurement system; comprising:
personal status sensors for mounting to a human including a respiration sensor and a heart rate
sensor and a hydration sensor;
inertial sensors for mounting to the human including three axis gyros and three axis
accelerometers;
- 10 an altimeter for mounting to the human;
a magnetic sensor for mounting to the human;
a differential global positioning satellite sensor for mounting to a human;
a motion classification unit having inputs connected to said inertial sensors and said altimeter
and said magnetic sensors, said motion classification unit having outputs for data
15 identifying motion type of the human and distance traveled by the human;
an energy estimator and health monitor unit having inputs connected to said personal status
sensors and said output of said motion classification unit for motion type data to output
energy expenditure information on the human motion and to trigger an alarm upon
traversal of a health threshold;
- 20 an inertial navigation unit connected to receive data from said inertial sensors and having a
navigation state output;
an input preprocessing unit having inputs connected to said global positioning satellite sensor

and said magnetic sensor and said altimeter and said motion classification unit and having an output;

a filter connected to receive data from said output of said input preprocessing unit, said filter having an output connected to said motion classification unit and said energy estimator and health monitor units and said inertial navigation unit;

5 a measurement prefilter connected between said input preprocessing unit and said filter; a human model provided as input to said measurement prefilter; an initial input to said input processing unit; and a human input to said input preprocessing unit.

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15. A method for monitoring human motion, comprising the steps of:

sensing motion and metabolism rate of a human;
classifying the motion of the human sensed in said sensing step; and
estimating energy expended by the human from the classified motion and from the
15 metabolism rate.

16. A method as claimed in claim 15, further comprising the step of:

triggering an alarm if a health threshold is traversed.

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17. A method as claimed in claim 15, further comprising the steps of:

providing landmarking position data for the human.